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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/065,739	11/14/2002	Roman Chistyakov	ZON-003	7509

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EXAMINER	
MCDONALD, RODNEY GLENN	

ART UNIT	PAPER NUMBER
1753	

DATE MAILED: 02/18/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/065,739	CHISTYAKOV, ROMAN	
	Examiner	Art Unit	
	Rodney G. McDonald	1753	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☐ Responsive to communication(s) filed on _____.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-30* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-30* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date *6/03,7/03,8/03,12/03.*
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

Claims 1, 3, 6-8, 11-19, 23-25 and 30 are rejected under 35 U.S.C. 102(b) as being anticipated by Kouznetsov (WO 98/40532).

Kouznetsov teach in Fig. 2 a ***magnetron sputtering*** device. The sputtering device has a sputtering chamber 1 and a target 9. ***The substrate 13 is attached to some electrically isolating support 15 at the end of a wall.*** (Page 8 lines 29-37; Column 9 lines 1-6) ***A magnet or magnets 17*** are mounted so that the north pole or poles are arranged at the periphery of the target and the south pole or poles at the center of the target 9. ***One electrode, the anode, is formed by the electrically conducting walls 5 of the housing 3, which e.g. can be grounded.*** The other electrode, ***the cathode, is formed by the target 9***, which is thus negatively biased in relation to the anode. The substrate 13 can have some neutral electric potential. A gas inlet for a suitable gas to be ionized such as argon is indicated at 21. (Page 9 lines 7-20)

When increasing the voltage form zero and on between the anode 5 and the cathode 9, there will for some applied voltage appear an electric glow discharge. ***The gas in the region between the anode and the cathode will be partly ionized by***

electrons. The ***electrons*** will be somewhat trapped or confined by the magnetic field primarily moving in the areas of low magnetic field intensity. (Page 9 lines 21-25)

An electric discharge occurs between the cathode and the anode producing electrons trapped in the magnetic field by cooperation of the electric field produced by the applied voltage. (Page 4 lines 27-31)

When increasing the voltage and current more, there will appear the state comprising ***completely ionized plasma region 27***, the region being stationary located above the surface of the target 9 and having a larger extension laterally, in the direction of the surface of the target 9 than the regions 23 of high electron and ion density used in ordinary sputtering. ***This state is made possible by the arrangement of the electric and magnetic fields crossing each other in the magnetron*** configuration. Furthermore, in this state, owing to the considerable extension and the relative homogeneity and uniformity of the ionized plasma in the region 27, ***ions will hit the target surface more regularly and uniformly distributed over the surface. This will result in a more homogeneous wear of the target surface,*** as illustrated by the area delimited by the dashed line 29 in Fig. 5b. (Page 10 lines 13-23)

The voltage will in this transfer from an arc discharge also increase suddenly to values of hundreds of volts, as stated above. Owing to the electrical current intensities which now are also very high, ***there will be a tremendous power developed in the ionized plasma, causing a very high rate of erosion of target material and also a very rapid increase of the temperature in the target.*** This state is therefore only maintained for a very short time, in the order of one hundred microseconds. The periods

of this state having the very high power developed are repeated regularly so that the average power developed will not be too high, allowing the thermal energy eventually resulting from the electric power generated to be conducted away or dissipated by the normal cooling circuits arranged in commercially available sputtering apparatus, for instance arranged in the target support table and possibly in the chamber walls. (Page 10 lines 24-34)

The power source is a pulse generator used primarily to produce coatings by sputtering. The power of each pulse can be in the range of 0.1 KW to 1 MW. ***The pulses can have a duration in the range of less than a hundred microseconds up to hundreds of microseconds and the intervals between pulses can range from milliseconds up to seconds.*** (Page 4 lines 14-23)

The electric circuit will be generate at the frequency of the main supply typically with ***a frequency of 50 or 60 Hz.*** (Page 12 lines 14-15)

Alternating current is supplied from the power supply. (Page 6 lines 15-16)

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 1, 3, 6-19, 23-25 and 30 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kouznetsov (WO 98/40532) in view of Fortov, "Encyclopedia of Low Temperature Plasma", Volume 3, page 123, 2000.

Kouznetsov is discussed above and all is as applies above. (See Kouznetsov discussed above)

The differences between Kouznetsov et al. and the present claims is that the relationship between yield and temperature of the sputtering is not discussed, the constant power and the constant voltage is not discussed.

Kouznetsov teach that during his process that at a certain point a very high rate of erosion of target material will occur and a very rapid increase in the temperature of the target will occur. (Kouznetsov Page 10 lines 24-34) This would be a non-linear relationship between sputter yield and temperature of the target since the amount of erosion is an increase in sputter yield.

As to the constant power and the constant voltage Kouznetsov's power supply provides this feature when operating in the crossed E and B field region since the power and voltage must be constant during this time period to produce a state of full ionization. (See Figure 1 Kouznetsov)

Furthermore, Fortov teach the sputter yield Y increases when the target temperature increases and this dependence has an exponential behavior which is a non-linear function. (See Fortov Translation page 123 provided by Applicant)

The motivation for utilizing a high sputtering yield with increase in temperature is that it allows for a more homogeneous wear of the target surface. (See Kouznetsov Page 10 line 22)

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to have modified Kouznetsov by utilizing a non-linear

relationship between sputter yield and target temperature as taught by Fortov because it allows for a more homogenous wear of the target surface.

Claims 4, 5, 20, 21 and 27-29 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kouznetsov in view of Fortov as applied to claims 1, 3, 6-19, 23-25 and 30 above, and further in view of Chiang et al. (U.S. Pat. 6,398,929).

The differences not yet discussed is the gas exchanging and exchange means controller.

Chiang et al. teach a cool plasma ignition and processing sequence is illustrated in the flow diagram of FIG. 12. After the wafer has been inserted through the load lock valve into the sputter reactor, the load lock valve is closed, and in step 190 gas pressures are equilibrated. ***The argon chamber pressure is raised to that used for ignition, typically between 2 and about 5 to 10 milliTorr,*** and the argon backside cooling gas is supplied to the back of the wafer at a backside pressure of about 5 to 10 Torr. In step 192, ***the argon is ignited with a low level of target power, typically in the range of 1 to 5 kW.*** After the plasma has been detected to ignite, in step 194, ***the chamber pressure is quickly ramped down, for example over 3s, with the target power held at the low level.*** If sustained self-sputtering is planned, the chamber argon supply is turned off, but the plasma continues in the SSS mode. ***For self-ionized plasma sputtering, the argon supply is reduced.*** The backside cooling gas continues to be supplied. Once the argon pressure has been reduced, in step 196, ***the target power is quickly ramped up to the intended sputtering level, for example, 10 to 24 kW or greater*** for a 200 mm wafer, chosen for the SIP or SSS sputtering. It is possible

to combine the steps 194, 196 by concurrently reducing pressure and ramping up the power. In step 198, the target continues to be powered at the chosen level for a length of time necessary to sputter deposit the chosen thickness of material. This ignition sequence is cooler than using the intended sputtering power level for ignition. The higher argon pressure facilitates ignition but would deleteriously affect the sputtered neutrals if continued at the higher power levels desired for sputter deposition. At the lower ignition power, very little copper is deposited due to the low deposition rate at the reduced power. Also, the pedestal cooling keep the wafer chilled through the ignition process. (Column 16 lines 9-42)

For gas exchange a gas source 114 supplies a sputtering working gas, typically the chemically inactive noble gas argon, to the chamber 52 through a mass flow controller 116. The working gas can be admitted to the top of the chamber or, as illustrated, at its bottom. (Column 11 lines 53-57) A vacuum pump system 120 is connected to the chamber 52 through a wide pumping port 122 and maintains the chamber at a low pressure. (Column 11 lines 61-63) (This is believed to suggest a gas exchange means in that the pump 52 removes a volume of gas as a volume of gas is admitted to the chamber from gas source 114. This "means" would apply for replacing volumes of either the "weakly-ionized" plasma (i.e. ignition gas plasma) or the "strongly-ionized" plasma (i.e. deposition plasma) and is required by Applicant's claims 4, 5, 20, 21, 27-29) A computer-based controller controls the reactor including the mass flow controller to control exchange of gas) (Column 11 lines 68; Column 12 lines 1-3)

The motivation for utilizing exchanging gas, a gas exchange means and gas exchange means controller is that it allows for self ionized sputtering. (Column 16 lines 25-26)

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to have utilized exchanging of the gas, a gas exchange means and gas exchange means controller as taught by Chiang et al. because it allows for self ionized sputtering.

Claims 2, 22 and 26 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kouznetsov in view of Fortov as applied to claims 1, 3, 6-19, 23-25 and 30 above, and further in view of Mozgrin et al. "High-Current Low-Pressure Quasi-Stationary Discharge in a Magnetic Field: Experimental Research", Plasma Physics Reports, Vol. 21, No. 5, 1995, pp. 400-409.

The differences not yet discussed is the use quasi-static field and ion density of the weakly ionized plasma and the highly ionized plasma.

Mozgrin teach utilizing a quasi-stationary discharge. (See Page 400)

Mozgrin et al. teach that the weakly ionized plasma, a pre-ionized plasma, should have a plasma density ranging from 10^7-10^9 cm^{-3}. (Page 401)

Mozgrin et al. further teach that during deposition a pulsed discharge can be utilized to deposit copper material in argon plasma with a plasma density of $3 * 10^{12}$ cm^{-3}. (Page 403-404)

The motivation for utilizing quasi-stationary discharge with particular ion densities during sputtering is that it allows for producing large volume dense plasmas and intense flow of charge particles. (Page 400)

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to have utilized quasi-stationary discharge with particular ion densities during sputtering as taught by Mozgrin et al. because it allows for producing large volume dense plasmas and intense flow of charge particles.

Double Patenting

The nonstatutory double patenting rejection is based on a judicially created doctrine grounded in public policy (a policy reflected in the statute) so as to prevent the unjustified or improper timewise extension of the "right to exclude" granted by a patent and to prevent possible harassment by multiple assignees. See *In re Goodman*, 11 F.3d 1046, 29 USPQ2d 2010 (Fed. Cir. 1993); *In re Longi*, 759 F.2d 887, 225 USPQ 645 (Fed. Cir. 1985); *In re Van Ornum*, 686 F.2d 937, 214 USPQ 761 (CCPA 1982); *In re Vogel*, 422 F.2d 438, 164 USPQ 619 (CCPA 1970);and, *In re Thorington,* 418 F.2d 528, 163 USPQ 644 (CCPA 1969).

A timely filed terminal disclaimer in compliance with 37 CFR 1.321(c) may be used to overcome an actual or provisional rejection based on a nonstatutory double patenting ground provided the conflicting application or patent is shown to be commonly owned with this application. See 37 CFR 1.130(b).

Effective January 1, 1994, a registered attorney or agent of record may sign a terminal disclaimer. A terminal disclaimer signed by the assignee must fully comply with 37 CFR 3.73(b).

Claims 1-30 are provisionally rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1-40 of copending Application No. 10/065,277 in view of Kouznetsov (WO 98/40532), Fortov, "Encyclopedia of Low Temperature Plasma", Volume 3, page 123, 2000 and Chiang et al. (U.S. Pat. 6,398,929).

The claims of U.S. Application 10/065,277 teach forming the weakly-ionized plasma and the highly ionized plasma as required by the claims of this application.

The difference between the claims U.S. Application 10/065,277 and the present claims is that the relationship between the sputtering yield and temperature of the target is not discussed, the exchanging of gas is not discussed and the means for exchanging the gas is not discussed.

Kouznetsov is discussed above and teach that the temperature will rise suddenly when exposed to a high rate of erosion (i.e. producing a high rate of sputtering yield) when exposed to a plasma that is fully ionized (i.e. highly ionized). (See Kouznetsov discussed above)

Fortov teach that the yield and temperature of the sputtering target have an exponential relationship. (See Fortov discussed above)

The motivation for utilizing a high sputtering yield having a non-linear relationship with the target temperature is that it allows for uniform erosion of the target. (See Kouznetsov discussed above)

Chiang et al. teach exchanging gas through control of a valve and pumping gas out of the chamber. (See Chiang et al. discussed above)

The motivation for utilizing an exchanging of the gas, a gas exchange means and gas exchange means controller is that it allows for self ionized sputtering. (See Chiang et al. discussed above)

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to have modified U.S. Application 10/065,277 by utilizing a

high sputtering yield having a non-linear relationship with the target temperature as taught by Kouznetsov and Fortov and to have utilized exchanging of the gas, a gas exchange means and gas exchange means controller as taught by Chiang et al. because it allows for uniform utilization of the target and for self ionized sputtering.

This is a provisional obviousness-type double patenting rejection.

Claims 1-30 are provisionally rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1-44 of copending Application No. 10/065,629 in view of Kouznetsov (WO 98/40532) and Fortov, "Encyclopedia of Low Temperature Plasma", Volume 3, page 123, 2000.

The claims of U.S. Application 10/065,629 teach forming the weakly-ionized plasma and the highly ionized plasma as required by the claims of this application.

The difference between the claims U.S. Application 10/065,629 and the present claims is that sputtering is not discussed and the relationship between the sputtering yield and temperature of the target is not discussed.

Kouznetsov is discussed above and teach plasma apparatus which is a sputtering apparatus that sputter a target and that the temperature of a target will rise suddenly when exposed to a high rate of erosion (i.e. producing a high rate of sputtering yield) when exposed to a plasma that is fully ionized (i.e. highly ionized). (See Kouznetsov discussed above)

Fortov teach that the yield and temperature of the sputtering target have an exponential relationship. (See Fortov discussed above)

The motivation for utilizing elements of a sputtering apparatus for producing a high sputtering yield having a non-linear relationship with the target temperature is that it allows for uniform erosion of the target. (See Kouznetsov discussed above)

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to have modified U.S. Application 10/065,629 by utilizing elements of a sputtering chamber for producing a high sputtering yield having a non-linear relationship with the target temperature as taught by Kouznetsov and Fortov because it allows for uniform utilization of the target.

This is a provisional obviousness-type double patenting rejection.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Rodney G. McDonald whose telephone number is 571-272-1340. The examiner can normally be reached on M- Th with Every other Friday off.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nam X. Nguyen can be reached on 571-272-1342. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Rodney G. McDonald
Primary Examiner
Art Unit 1753

RM
February 11, 2004